Estimating Soil Loss From Gully Erosion

ESTIMATING SOIL LOSS FROM GULLY EROSION - EPHEMERAL OR CLASSIC

Definitions

Ephemeral Gully - A shallow channel cut by concentrated runoff where soil loosened by mechanical operations is removed, generally between tillage operations. An ephemeral gully typically erodes to the tilled depth. If untreated, the ephemeral gully may develop into a classic gully over time. In general, this type of gully can be crossed with farm equipment and obliterated with tillage. Although tillage removes the visible erosion, tillage moves soil into the voided area and loosens soil material for the next rainfall event.

Newly Formed Gullies -The soil loss from newly formed gullies, and other similar types of erosion will be determined by calculating the volume of soil removed from the eroded area. The tons of soil loss can then be determined by multiplying the volume removed by the unit weight of the soil. If the time period of the erosion exceeds one year (up to 5 years), the quantity should be divided by the number of years the gully has existed to get an average annual rate.

Classic Gully - A channel or miniature valley cut by concentrated runoff into the earth, but through which water commonly flows only during and immediately after rains. A gully may be either branching or linear (long, narrow, and of uniform width) with a width and depth that prevents normal tillage or equipment crossing of the gully. Erosion from classic gullies, gullies present for more than 5 years, will be estimated using the head cut formula and/or the side wall erosion formula. Branches of a gullies will be calculated individually and added together to get the total for the gully system.

Procedures

Ephemeral gully:

Ephemeral gullies are shallow cuts that form where rills converge to form a single watercourse (see Figure 1). They do not normally exceed the plow depth, are rarely more than 1 foot deep, and generally have nearly vertical sides (see Figures 2 and 3). Therefore, a difference in the top width and bottom width is not significant. It is important to note that the ephemeral calculations are made on a field by field basis, and that the erosion above the point where rills converge, as

well as, the side slopes of incised watercourses are accounted for in the RUSLE2 calculations. Refer to Tables 1, 2, 3, and 4 for estimated erosion rates associated with different depth, width, and length combinations. For ephemeral gully dimensions (width, depth or length) that exceed the increments shown in these tables, combine the erosion rates from two or more columns that equate to the actual size.

The tables are based on the following formula. This formula may be used to estimate the ephemeral gully soil loss in lieu of using the tables:

$L \times W \times D_i / 12 = V$

Where: **L** is the total length in feet;
W is the average width in feet;
D_i is the average depth measured in inches; and
V is the displaced volume in cubic feet.

To convert this calculated volume into a weight of soil lost since the last tillage operation, use the following formula:

$(V \times 90 / 2000) \times N = E$

Where: **V** is the volume in cubic feet calculated above;
90 is the average weight of soil in pounds per cubic foot;
2000 is the weight in pounds per ton;
N is the number of similar ephemeral gullies;
E is the current soil loss in tons per year.

NOTE: Ephemeral gully erosion occurs between seasonal tillage operations. **The number of years that the gully has been active will always be equal to 1 for an ephemeral gully.** On intensively tilled cropland, ephemeral gullies may form and reform between tillage operations in any given year. The formula above calculates the erosion that occurred since the most recent tillage operation. The location, estimated length, width, and depth of all ephemeral gullies for which erosion is calculated will be documented on the plan map or soil map in the office copy of the producer's file.

Figure 1 – Rills Converge to Create an Ephemeral Gully

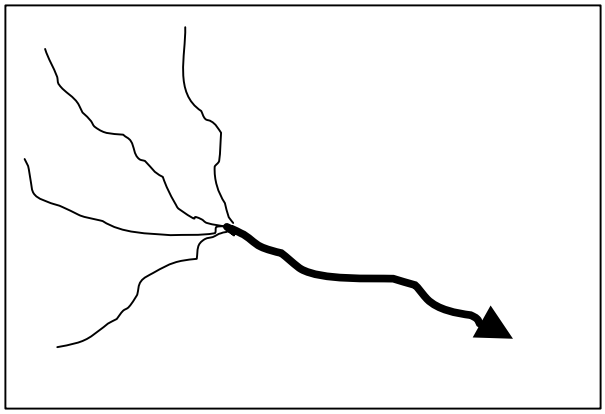


Figure 2 – Wide Shallow Ephemeral Gully

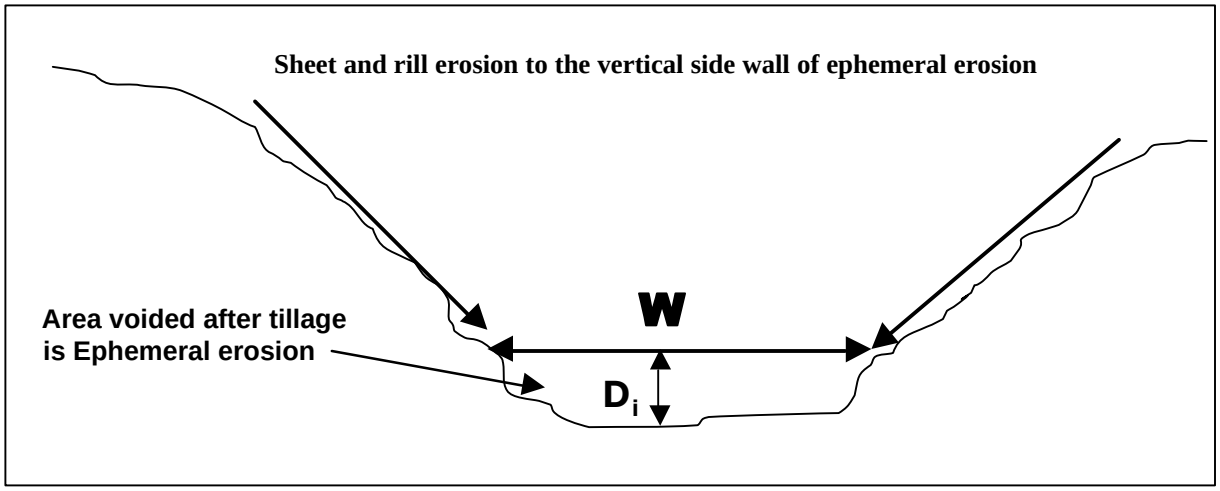
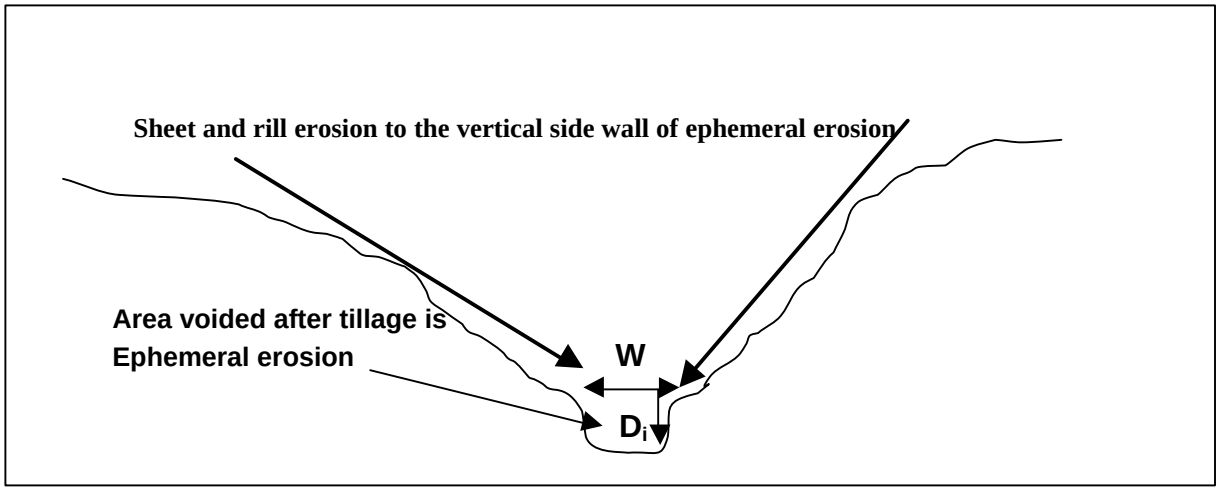


Figure 3 – Narrow Deep Ephemeral Gully



ESTIMATED TONS OF EPHEMERAL GULLY EROSION*

TABLE 1 - DEPTH OF EROSION EQUALS ***2 INCHES***

W (ft) / L (ft)	1	2	3	4	5	6	7	8	9	10
25	**	**	1	1	1	1	1	2	2	2
50	**	1	1	2	2	2	3	3	3	4
75	1	1	2	2	3	3	4	5	5	6
100	1	2	2	3	4	5	5	6	7	8
125	1	2	3	4	5	6	7	8	8	9
150	1	2	3	5	6	7	8	9	10	11
175	1	3	4	5	7	8	9	11	12	13
200	2	3	5	6	8	9	11	12	14	15
225	2	3	5	7	8	10	12	14	15	17
250	2	4	6	8	9	11	13	15	17	19
275	2	4	6	8	10	12	14	17	19	21
300	2	5	7	9	11	14	16	18	20	23

TABLE 2 - DEPTH OF EROSION EQUALS ***4 INCHES***

W (ft) / L (ft)	1	2	3	4	5	6	7	8	9	10
25	**	1	1	2	2	2	3	3	3	4
50	1	2	2	3	4	5	5	6	7	8
75	1	2	3	5	6	7	8	9	10	11
100	2	3	5	6	8	9	11	12	14	15
125	2	4	6	8	9	11	13	15	17	19
150	2	5	7	9	11	14	16	18	20	23
175	3	5	8	11	13	16	18	21	24	26
200	3	6	9	12	15	18	21	24	27	30
225	3	7	10	14	17	20	24	27	30	34
250	4	8	11	15	19	23	26	30	34	38
275	4	8	12	17	21	25	29	33	37	41
300	5	9	14	18	23	27	32	36	41	45

* Using formulas on page 2 of this guidance.
** Insignificant amounts (less than 1 ton)

ESTIMATED TONS OF EPHEMERAL EROSION*

TABLE 3 - DEPTH OF EROSION EQUALS ***6 INCHES***

W (ft) / L (ft)	1	2	3	4	5	6	7	8	9	10
25	1	1	2	2	3	3	4	5	5	6
50	1	2	3	5	6	7	8	9	10	11
75	2	3	5	7	8	10	12	14	15	17
100	2	5	7	9	11	14	16	18	20	23
125	3	6	8	11	14	17	20	23	25	28
150	3	7	10	14	17	20	24	27	30	34
175	4	8	12	16	20	24	28	32	35	39
200	5	9	14	18	23	27	32	36	41	45
225	5	10	15	20	25	30	35	41	46	51
250	6	11	17	23	28	34	39	45	51	56
275	6	12	19	25	31	37	43	50	56	62
300	7	14	20	27	34	41	47	54	61	68

TABLE 4 - DEPTH OF EROSION EQUALS ***8 INCHES***

W (ft) / L (ft)	1	2	3	4	5	6	7	8	9	10
25	1	2	2	3	4	5	5	6	7	8
50	2	3	5	6	8	9	11	12	14	15
75	2	5	7	9	11	14	16	18	20	23
100	3	6	9	12	15	18	21	24	27	30
125	4	8	11	15	19	23	26	30	34	38
150	5	9	14	18	23	27	32	36	41	45
175	5	11	16	21	26	32	37	42	47	53
200	6	12	18	24	30	36	42	48	54	60
225	7	14	20	27	34	41	47	54	61	68
250	8	15	23	30	38	45	53	60	68	75
275	8	17	25	33	41	50	58	66	74	83
300	9	18	27	36	45	54	63	72	81	90

* Using the formulas on page 2 of this guidance.
** Insignificant amounts (less than 1 ton)

Newly formed and classic gully erosion variables:

A = top width
B = bottom width
C = depth
D = length
E = soil unit weight*
F = headward advancement
G = average annual rate of sloughing or recession
H = number of years
N = number of sides sloughing
*The average unit weight of 90 pounds per cubic foot soils can be used in the absence of site specific data.

Newly formed gully example–

Eroded silt loam soil; 20 ft top, 2 ft bottom, 3 foot deep, and 600 ft in length. Formed in 2 years.

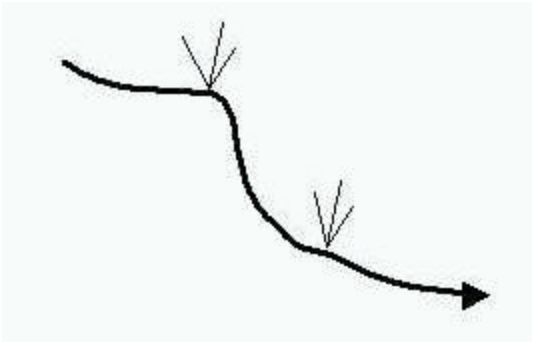
$$\frac{(A+B) \times C \times D \times E}{2 \times 2000 \times H} = \frac{(20+2) \times 3 \times 600 \times 90}{2 \times 2000 \times 2} = 445.5 \text{ tons/yr}$$

Classic Gully -

1. Head Cut – Erosion Categories:

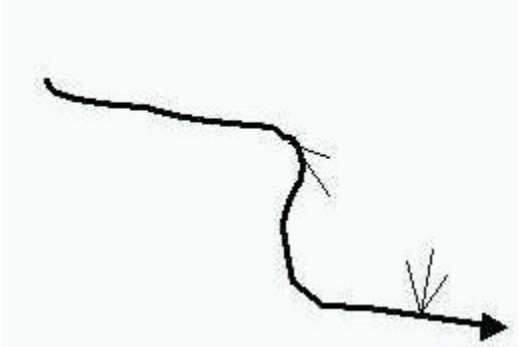
a. **Minimal** - Less than 1-foot annual advancement, nearly stable, no sign of advancement. No undercutting present. Some vegetation established or becoming established on head cut slopes or at bottom of the head cut area. Implementation of conservation practices that will reduce runoff from contributing acreage will probably be all that is needed to continue the stabilization of the gully.

Minimal Head Cut



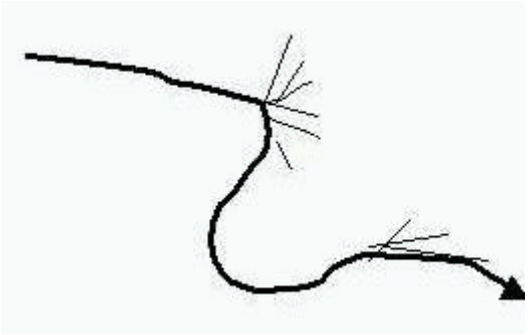
b. **Slight** - Head cut is bare some sign of advancement, small pieces of soil sloughed off, some exposed roots, slight undercutting. Gully system nearing stable condition. Erosion resistant materials may be present or the head cut may be nearing the top of the drainage area or other physical barrier. Implementation of conservation practices that will reduce runoff from contributing acreage or perhaps fencing to exclude livestock should be considered as the first step to stabilizing the gully.

Slight Head Cut



c. **Moderate** - Head cut is bare and active advancement is visible, cut area is bare. Newly exposed roots, fallen woody and/or herbaceous vegetation, moderate amounts of soil sloughed off, and undercutting are apparent. Potential exists for gully to continue up slope.

Moderate Head Cut



d. **Severe** - Head cut is bare and headward advancement is very obvious. Fresh exposures of eroded soil present. Significant sloughing off of soil, herbaceous and/or woody vegetation, etc. Active undercutting and stair stepping of collapsed material immediately below the head cut.

Severe Head Cut

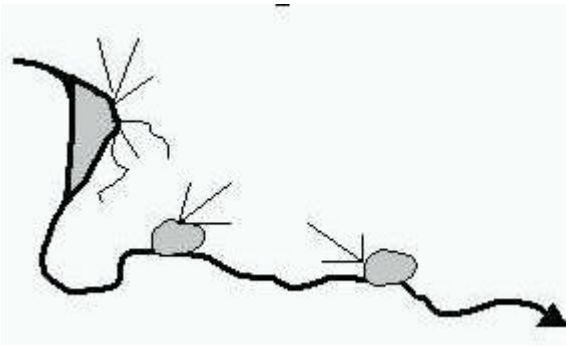


Table 5 - Guide to Estimating Head Cut Advancement:

Erosion Category	Avg. Annual Advancement (ft/yr)
Minimal	< 1
Slight	1 - 3
Moderate	>3 - 6
Severe	>6 - 10

The rates of head cut advancement in **Table 5** will be used unless documentation is provided to justify higher values. A photo of the head cut "before" condition should be included in the case file for documentation of erosion category used.

Head Cut Example – 6 ft deep, 30 ft top, 6 ft bottom, advancing 5 ft /year.

$$\frac{(A+B) \times C \times F \times E}{2 \times 2000} = \frac{(30+6) \times 6 \times 5 \times 90}{2 \times 2000} = 24.3 \text{ tons/yr}$$

Side Wall – Erosion Categories

a. **Minimal** – Less than 0.05 feet annual advancement, nearly stable, no sign of advancement. No sloughing of banks present. Scattered herbaceous vegetation and/or woody vegetation established or becoming established on side slopes or bottom of the gully. Implementation of conservation practices that will reduce runoff from contributing acreage will probably be all that is needed to continue the stabilization of the gully.

b. **Slight** – Banks are bare, but lateral recession is not obvious, very short lengths of roots from herbaceous and/or woody vegetation recently exposed.

c. **Moderate** – Actively eroding bare sides. Roots of herbaceous and/or woody vegetation occasionally exposed to several inches in length, some vegetation and/or small chunks of topsoil soughed off along the sides or into gully bottom.

d. **Severe** – Obvious lateral recession of bare sides. Many herbaceous and/or woody roots recently exposed. Fallen woody vegetation, large chunks of sod, and/or large chunks of topsoil and subsoil sloughed off along the side or into the bottom of the gully.

Table 6 – Guide to Estimating Side Wall Recession:

Erosion Category	Avg. Annual Recession (ft/yr)*
Minimal	< 0.05
Slight	0.05 – 0.10
Moderate	>0.10 – 0.20
Severe	>0.20 - .30

*Rates higher than those in **Table 6** may occur in recently formed gullies in cropland or other unconsolidated or disturbed conditions. Higher rates should be documented in detail. Remember formula 1 must be used on recently (1 - 5 years old, age can be verified) formed gullies or gullies formed from single storm events. A photo of the side-wall advancement of the gully should be kept in the folder to document the before condition of the gully.

Side Wall Example - 2 sides sloughing, 1560 feet long, 8 feet high, sloughing 0.25 ft/yr.

$$\frac{N \times C \times D \times G \times E}{2000} = \frac{2 \times 8 \times 1560 \times 0.25 \times 90}{2000} = 280.8 \text{ tons/yr}$$

These methods, unlike RUSLE, estimate past erosion and cannot predict future erosion.